THE SPORES OF THE GENUS SELAGINELLA IN NORTH CENTRAL AND NORTH EASTERN UNITED STATES

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(Plates 380 and 381)

THAT spores of Pteridophytes may be used in the identification of species is illustrated in the genus *Isoetes*[1] and in the genus *Lycopodium*.[2] It is also apparent that the spores of the genus *Selaginella* likewise show specific characters.

The spores were obtained from herbarium specimens from various parts of the United States. The preparation of the material consisted of soaking the specimens in warm water to facilitate removal of the sporangia; boiling the spores for a few seconds in 10% KOH on a slide; washing a number of times in distilled water; and mounting in glycerine jelly. In some cases the spores were heated in water in a watch glass over a beaker of boiling water; glycerine jelly containing a stain was then added and evaporated to the desired consistency for mounting. The KOH was used to clear the spores so that the exine features would be more distinct. Staining with methyl green in glycerine jelly was found to be very satisfactory. The use of safranine used after the KOH treatment was also a good method providing the spores were left in the stain for only a few seconds. In some cases staining was unnecessary.

The spores were examined under a compound microscope using a 7.5 × ocular and the 4 mm and 16 mm objectives for the micro- and megaspores respectively. The outlines of the surface features were traced with the aid of a camera lucida. The apical surface is that upon which the germinating slits are found, and the basal surface (more or less dome-shaped) is the opposite surface. With the exception of *Selaginella rupestris*, the drawings are of these two surfaces for both micro- and megaspores. In that species, however, the apical surface as it appears for the spores of the other species is absent and the drawings were made of the two types found. A slight variation in size, shape, and pattern of the spores occurs, due to age, condition, and treatment of the specimens; but the distinguishing characters are quite readily found. Many spores of each species were examined and typical individuals were chosen for the drawings.

[1] Gray's Manual, 7th Edition. A. A. Eaton.

[2] Wilson, L. R. 1934. Spores of the genus *Lycopodium* in the United States and Canada. RHODORA. **36**: 13–19.

The species here treated are *S. selaginoides*, *S. apoda*, *S. rupestris*, and *S. densa*. These four species show unmistakable characters in the ornamentation of both micro- and megaspores.

In *S. selaginoides* the microspores are spinose on the basal side, each having twenty-five to thirty-two blunt spines which are nearly flat across the point and average 8 mu in length (Plate 380). The apical surface is smooth and the germinating slits are on prominently raised ridges, each of which extends nearly the full radius of the spore. The spores themselves are very slightly triangular in outline, and measure from 32 to 38 mu in diameter exclusive of the spines.

The megaspores of this species are large, ranging from 580 to 600 mu in diameter, and appearing pale yellow and about one-third the size of a pin-head to the naked eye. The exine is distinctly papillate on both the apical and basal surfaces. The numerous papillae are from 3 to 3.5 mu in width, and from 5 to 7 mu in length (Plate 381). In both micro- and megaspores the apical surface is similar to a flattened pyramid, the basal surface like a more or less flattened dome.

The microspores of *S. apoda* are the smallest of any of the four species, ranging from 24 to 27 mu in diameter (Plate 380). Both the apical and the basal surfaces are marked by small, dome-like ridges averaging about 3 mu across, so that the spore coat sometimes appears to be pitted. The germinating slits are prominent.

The megaspores are likewise the smallest of the four species, ranging from 330 to 370 mu in diameter (Plate 381). The basal surface is marked by ridges of reticulation which range from 25 to 50 mu in distance apart. Many of these ridges lower into the general level of the spore coat; and around the edge of the spore the ridges appear as a folded, translucent margin. On the apical surface the reticulation fades into wrinkles and folds in the exine near the edge. The central portion of the apical surface is relatively smooth, marked by only a few minor wrinkles. The germinating slits are on a prominent ridge.

Both the micro- and megaspores are nearly circular in outline and appear to be slightly more spherical than those of *S. selaginoides*.

The spores of *S. rupestris* show distinctly different characters from those of the other three species. Both micro- and megaspores vary considerably in size, and "dumb-bell" spores are quite common, occurring one in every thirty or forty spores. The single microspores are from 45 to 60 mu in diameter and are marked by wrinkles which vary from few to many on the spore coat (Plate 380). The single megaspores range from 300 to 500 mu in diameter and are

heavily reticulate (PLATE 381). The ridges of reticulation are drawn into a disconcentric ring of papillae-like ends where the spores were attached previous to division. Both micro- and megaspores are more or less spherical and are without an apical surface such as is found on the spores of the other species, indicating that they occur from a diad formation. The "dumb-bell" spores in each case have smaller diameters at each end than the diameters of the single spores.

In none of the *S. rupestris* material examined were tetrads of spores found, or was there any indication of an apical surface as is typical of the spores formed from tetrad division. Miss Mitchell[1] states that *S. rupestris* was found to have several cases of inequality in the size of the spores, and that "in *S. rupestris* there are normally two spores" in the megasporangium, and that sometimes one megaspore of correspondingly large size was found. Miss Lyon[2] figures the "dumb-bell" spores of *S. rupestris*, but fails to describe any differences in the appearance of spores found in megasporangia containing more than two spores, and whether or not they had germinating slits. Sterile spores have been known to be common in this species, and the variability in size, and the presence of "dumb-bell" spores is indicative of hybridization.[3]

In *S. densa* the diameter of the microspores is from 37 to 42 mu. The basal surface is papillose, the tiny papillae appearing only about one micron in width and not profuse. The apical surface is not definitely ornamented and the germinating slits are on a prominent ridge (PLATE 380).

The megasporangia of this species are heavily reticulate on both the basal and the apical surfaces, the reticulation on the apical surface being much closer and the ridges appearing folded together near the germinating slits, sometimes running into the ridge of the germinating slit. The diameter of the megaspores ranges from 350 to 390 mu (PLATE 381).

Like *S. apoda*, the reticulation at the edge appears as a folded translucent margin; however, there are considerably fewer ridges which lower to the general level of the exine. The ridges of reticulation on *S. densa* range from 20 to 30 mu apart on the basal surface and slightly closer together on the apical surface. The spores of *S. densa*

[1] Mitchell, G. 1910. Contributions towards a knowledge of the Anatomy of the genus *Selaginella*, Spr. V. The Strobilus. Ann. of Bot. V. XXIV.

[2] Lyon, F. M. 1901. A study of the sporangia and gametophytes of *Selaginella apus* and *Selaginella rupestris*. Bot. Gaz. V. XXXII. 124–141, 170–194.

[3] Graustein, J. E. 1930. Evidences of Hybridization in *Selaginella*. Bot. Gaz. V. XC. 46–74.

appear even slightly more spherical than those of the first two species.

Some authors reduce *S. densa* to a variety of *S. rupestris;* however, its constant vegetative and spore characters would indicate that it is a distinct species. In no cases were the spores found to vary from tetrad formation in *S. densa.* Further work on the *S. rupestris* group is now in progress.

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THE GENUS NAJAS IN MINNESOTA

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(Plate 382)

Three species of *Najas* have hitherto been recorded for Minnesota. These are *N. marina, N. guadalupensis,* and *N. flexilis.* The first named species is represented in the University herbarium by only two collections, one from Lake Minnewashta in Pope County, the other from Big Stone Lake on the western border. Both are fresh water lakes. *N. guadalupensis* is likewise known from only two stations, one at Winona, the other in Jefferson Township, Houston County, in the extreme southeastern corner of the state. The two species are obviously rare within our borders, but undoubtedly more careful search in the respective areas would locate more stations. *N. flexilis,* on the other hand, is very generally distributed throughout the entire state except in the northeastern corner, and in many of our lakes it is one of the most abundant species of aquatic plants. It is quite variable as regards size and habit of growth, ranging from small tufted forms 2–3 inches high on sandy or rocky bottoms in shallow water to long stringy plants 3–4 feet long, rooting in the muck at depths of 4–8 feet. In addition to vegetative differences, there is considerable variation in the form and size of the seed, but whether these variants can be referred to some of the subspecific segregates that have already been described or whether they represent new varieties or forms can be determined only by more detailed investigation.